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AUTHOR Ibarra, Hector
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ABSTRACT

This paper reports on a small scale study undertaken at the University of Iowa to examine whether students perceive a difference as to the value of learning in General Education Requirement (GER) science classes compared to learning in science application courses. It also explores the need for a different approach to the teaching of science courses for non-science majors. Sixteen students were given a questionnaire that elicited the students' perceptions of the GER science courses and the science application courses they had taken. Results indicate dissatisfaction with GER courses when compared with science application courses. All respondents indicated that science application courses provided a better environment for developing student creativity than the GER science courses and also encouraged students to actively practice science and to apply the activities to real world situations. It was concluded that this study supports the statement that many students are turned off by the traditional science courses oriented around a lecture format with memorization of facts. Contains 14 references. (JRH)

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A Different Kind of Science for the Non-science Major

by Hector Ibarra

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A Different Kind of Science for the Non-science Major

Hector Ibarra

A small scale study was undertaken to examine two fundamental questions. 1. Do students perceive a difference as to the value of learning in GER science classes compared to learning in science application courses? 2. Is there a need for a different approach to the teaching of science courses for non-science majors?

Most college science classes are lecture and content oriented. These courses are treated as a body of knowledge and methodology and shed little light on the scientists' way of thinking or working (Ganem,1993). Typically, university or college science departments have ignored critical thinking skills for non-science major students by demanding that they first learn detailed, discrete facts (Yager and Huang, 1994). Educators and many scientists argue that science education should concentrate more on science process skills (scientific method) and less on memorization of facts (Lawson, Rissing, and Faeth, 1990; Medve and Pugliese, 1987; Schamel and Agres, 1992). Most students and adults learn best with concrete, hands-on experiences (Knott, 1992; Mechling and Oliver, 1983; Sojka, 1992). In support of this is the Chinese proverb:

"To hear is to forget,
To see is to remember,
To do is to understand."

Undergraduates, especially at large universities, need to be intellectually engaged in problem solving and learning how science

works (Merriam, 1993). Learning becomes interactive, rather than passive (Woods, 1993). Herrid (1994) writes that many students are turned off by the traditional science courses oriented around a lecture format with concentration on facts and content rather than the development of higher-order thinking skills. 95% of non-science majors attended class when case studies were used as a teaching approach as compared to 50-65% attendance in the normal lecture courses.

To raise the level of scientific literacy, we must require substantially more science of the non-science undergraduates. Non-science majors have special interests and need to be taught differently from their science major classmates. Students may be overloaded with details which they do not learn well and that may even interfere in their learning. Concepts rather than details are important to build a more solid foundation upon which to construct understanding of science (Sundberg and Dini, 1993). Research studies show that courses heavy in memorization shed little light on the scientists' way of thinking or working (Ganem,1993).

Elementary and secondary science education majors represent a significant contingent of non-science majors. Qualified elementary and secondary science teachers need to be prepared to meet the needs of their students. If the pool of scientists is to be increased, 1) more students must be attracted to science very early in their schooling, and 2) elementary schools need to emphasize "hands-on" activities.

At the University of Iowa, college students have said too many required courses take too much time and keep them from taking courses they want. Current university policy requires students to take

two courses (1 with lab) totaling seven hours in the natural sciences in order to meet the General Education Requirement (GER) (Source: Office of the UI Dean of Liberal Arts). A proposal was developed that would reduce the natural science requirement to 1 course, with lab for a total of four hours. Tim Williams, UI student government vice-president, stated, "A lot of students feel one class is sufficient for introducing them to something. If you like it, you'll take more." (Press Citizen, 1995). The proposal was not given final approval by the liberal arts faculty assembly at its January 1996 meeting.

This reduction in the number of semester hours in the area of science would have had detrimental affect on the science literacy of students. The lack of science could cause future elementary teachers to teach less science than is currently taught and the middle school teachers could continue to primarily use the textbook as their course outline. Add to this the fact that science related topics are too "little spoken" in the nation's households and there are too few science role models for young people to emulate (Tobias, 1990) causes concerns.

The University of Iowa offers students the choice to enroll in science application courses. Science application courses offered at the University of Iowa include: 97:102 Societal and Educational Applications of Earth Sciences and Environmental Sciences, 97:103 Societal and Educational Applications of Biological Sciences, 97:105 Societal and Educational Applications of Physical Sciences, and 97:106 Societal and Educational Applications of Chemical Concepts, 97:107 Textile Sciences, and 97:108 Experimental Textile Science.

The fact that GER science courses as well as science application

courses are available to students raises some interesting questions. 1. Are the application science courses taught differently from the introductory GER science courses? 2. Do the students have different expectations of the science application courses? 3. Are the students in the application science courses aspiring to be teachers? 4. Why do students not enrolled in the college of education opt to take the application science courses? 5. Is the way science is currently taught the best way to meet the needs of the science non-majors? 6. Are students turned off by traditional science courses that are oriented towards a lecture format with a concentration on facts and content rather than the development of higher order thinking skills?

Methodology

The group studied included sixteen students enrolled in 97:102 Societal and Education Applications of Earth Science and Environmental Sciences. This group was selected because students enrolled in the science application course had taken numerous GER science courses and were at different stages in attaining their degrees. This study was undertaken after the researcher had attended four three hour classes. This time spent in attendance gave the researcher background information on the content of the class, interactions in class, and an acquaintance with the students. A questionnaire was administered using questions posed to elicit the students perceptions of the GER science courses and science application courses they had taken. Nine students (four elementary science education majors, four secondary science education majors, and one interdepartmental studies major) were asked two open-ended questions in addition to completing the

questionnaire. The questions were designed to glean further information from the respondents regarding what impressed them the most about their GER science courses and science application courses. The surveys and interviews provided demographic information as well as insight into respondent perceptions about the GER science courses and science application courses.

Table 1 summarizes demographic data for the sample. Of the fifteen respondents, nine were males and six were females. Three students were sophomores, six were juniors, three were seniors, and three were in graduate school. Age ranged from less than 19 (2 respondents) to older than 25 (3 respondents). The majority of the respondents (8) fell in the 20-22 year old age group with the final two respondents falling in the 23-25 age bracket. Elementary science education was the area of study for 5 respondents, secondary science education for 9 respondents, and one respondent indicated interdepartmental studies as the selected area of study. All of the respondents had taken at least five GER science courses in college prior to participating in this study. Three respondents indicated they had taken 5-6 science courses, four respondents indicated they had taken 7-8 science courses, while 8 respondents indicated they had taken more than nine college science courses.

Table 2 lists the questions on the questionnaire and the student responses. Quantitative analysis in terms of frequency of responses was undertaken. The frequency of responses to the range of "strongly agree, agree, neither agree or disagree, disagree, or strongly disagree" is also shown.

Responses indicated dissatisfaction with GER courses when compared with science application courses. Seven respondents indicated that high school science did not prepare them more for science application courses than GER science courses. Thirteen respondents indicated GER courses required more memorization. Thirteen respondents found the classroom environment in GER classes to be more impersonal. The professor's lectures were found to be less understandable by seven respondents when compared to application courses. Ten respondents indicated attendance at GER classes was not as regular as attendance at science application classes. Ten students found the professor in the GER courses to be less available for assistance than in the science application courses. Peers were less willing to answer questions in GER classes as indicated by thirteen respondents.

Science application courses faired more favorably as viewed by the students. Lab instruction in science application courses was found by eleven respondents to be more interesting than that of GER courses. The classroom environment in the science application courses encourages discussion of questions and issues between students and the professor as indicated by thirteen respondents. Ten respondents indicated science application courses had provided more positive experiences related to their major in science education. All fifteen respondents indicated they agreed or strongly agreed that science application courses provided a better environment for developing student creativity than the GER science courses as well as encouraging them to actively practice science and to apply the activities to real

world situations. Finally, eleven students agreed or strongly agreed that science application courses provided more opportunities for resolving problems related to science and technology.

Statements eliciting neutral responses include those related to ease of study, challenge, working for a grade, and opportunities for understanding scientific attitudes.

Qualitative analysis was undertaken to summarizes responses to the two open ended questions. These questions were: 1. In general, what impresses you the most about science application courses? 2. In general, what impresses you the most about general education required science courses? Eight themes emerged in this analysis. They are presented in Table 3. These themes included cooperation, content, application, curriculum development, hands-on activities, student-teacher interaction, concept building, and nothing. Science application courses impressed respondents in the areas of cooperation (N = 6), application (N = 7), curriculum development (N = 3), hands-on activities (N = 6), and student-teacher interaction (N = 3). GER courses impressed students in the area of content (N = 5), application (N = 1), hands-on activities (N = 2), student-teacher interaction (N = 1), concept building (N = 3), and nothing (not impressed at all) (N = 5).

Cooperation is exemplified by one student's statement, "We have a small class where interaction is taking place. We get to share ideas and discuss things that interest us." "Hands-on activities are what impressed me the most about science application courses," responded one student. Application was described by the statement, "It is gratifying to me to get a chance to use my mind for once, instead of just

being given a set of facts to memorize." The statement, "The one-on-one opportunities between student and instructor" shows the value one student found for the theme of student-teacher interaction. Content was discussed most frequently in relationship to GER classes. One student responded, "GER sections get into greater detail. You need GER classes for building concepts."

Students also wrote comments about what impressed them the least about GER science courses. One student wrote "Discussions are often absent from GER courses in science. Although included in the syllabus, the instructor usually uses (discussion) as an overflow reservoir for extra needs of the course. They are seldom used in an essential manner." A second comment was "The principles and concepts that are taught generally lead to preparation for a future in a science career and little is gained by the person striving for other disciplines." Finally, one student wrote that lab sections in GER science courses "are often abused as learning environments."

Conclusion

The study supports Herreid's statement that many students are turned off by the traditional science courses oriented around a lecture format with memorization of facts. The students in this study found the GER courses to usually be large and impersonal. The science application courses provided hands-on activities in a cooperative learning environment with a greater emphasis on problem solving and the process of science.

Science becomes interesting when students are able to apply the

scientific process as they learn about natural phenomena and real world experiences. Memorizing vast amounts of information and methodology is rote learning of facts that reduces the potential for mental processing. Professors should adopt a teaching style in GER courses that encourages questioning and exploration as well as creativity. This may be especially important to elementary and secondary science education majors who must learn to teach how the process of science works as they prepare today's students for the future in which science is extremely important.

"Schools (universities) around the nation are seeking curriculum reform and classroom innovations to aid in rectifying the deficiencies in scientific literacy" (Herreid, 1994). From a university perspective decisions must be made about what steps to take. A promising example of action is the Center for Teaching/Northwest Bank Summer Fellowships for Curriculum Innovation program designed to give University of Iowa faculty time and opportunity to rethink traditional course plans (Hauser, 1996). This will offer an opportunity to explore new ideas for creating effective learning environments for all students.

Table 1. Demographic information about the respondents

Demographic criteria	Respondent information
Gender	Male = 9 respondents Female = 6 respondents
Year in college	Sophomore = 3 respondents Junior =6 respondents Senior =3 respondents Graduate = 3 respondents
Age	<19 years old = 2 respondents 20-22 years old = 8 respondents 23-25 years old = 2 respondents >25 years old = 3 respondents
Major	Elementary science education = 5 respondents Secondary science education = 9 respondents Interdepartmental studies = 1 respondent
Number of science courses taken previous to the current science application course	1-4 courses = 0 respondents 5-6 courses = 3 respondents 7-8 courses = 4 respondents >9 courses = 8 respondents

Table 2. Quantitative analysis: frequency of responses to study questions

Questions	Strongly disagree	Disagree	Neither agree or disagree	Agree	Strongly agree
1. The science courses I took in high school prepared me more for the application science courses than the GER science courses.	3	4	7	1	0
2. The GER science courses require more memorization of facts than the application science courses.	0	0	2	8	5
3. Lab instruction in the science application courses is more tedious and dull than the GER courses.	2	9	4	0	0
4. The classroom environment in the GER classes is more impersonal with little interactions between students than the application science courses.	1	1	0	4	9
5. The classroom environment encourages discussion of questions and issues between students and the professor more in the application courses than the GER science courses.	0	0	2	7	6
6. I find it easier to study for the GER courses than the application courses.	1	5	5	3	1
7. Science application courses have provided more positive experiences than the GER courses related to my major in science education.	0	1	4	4	6
8. The GER courses are more understandable than the application courses in terms of the professor's lectures.	1	6	6	2	0
9. My attendance at GER classes is/was more regular than attendance at application courses.	1	9	5	0	0
10. The professor in the GER courses is available to help me more than in the application science courses.	3	7	5	0	0

Table 2. (continued) Frequency of responses to study questions

Questions	Strongly disagree	Disagree	Neither agree or disagree	Agree	Strongly agree
11. Science application courses are more challenging than the GER science courses.	0	5	6	2	2
12. I had to work harder for my grade in the science application courses than in the GER science courses.	0	5	6	2	2
13. If I have questions, my peers in my GER classes are more willing to help me than my peers in my science application classes.	2	8	4	1	0
14. The science application courses provided a better environment for developing student creativity than the GER science courses.	0	0	0	8	7
15. The science application courses encouraged me more than the GER science courses to actively practice science and apply the activities to real world situations.	0	0	0	7	8
16. The GER science courses provided more opportunities than the science application courses for a better understanding of the scientific attitudes of critical-mindedness, questions, problem solving, and open mindedness.	2	5	6	1	1
17. The science application courses provided more opportunities than the GER courses for resolving problems related to science and technology.	0	3	1	7	4

Table 3. Qualitative analysis: Frequency of response themes to the open ended questions identifying what impressed respondents the most about the classes

	Cooperation	Content	Application	Curriculum development	Hands-on activities	Student-teacher interaction	Building concepts	Nothing
GER courses		5	1		2	1	3	5
Science application courses	6		7	3	6	3		

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